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(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

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DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

L9289.01124 PCT

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

New Application

09/806027

INTERNATIONAL APPLICATION NO.

PCT/JP00/05048

INTERNATIONAL FILING DATE

July 28, 2000

PRIORITY DATE CLAIMED

July 30, 1999

TITLE OF INVENTION

APPARATUS AND METHOD FOR RADIO COMMUNICATIONS

APPLICANT(S) FOR DO/EO/US

Takahiro SHOJI, Toyoki UE and Osamu KATO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Claim for Priority w/ PCT/IB/304

PCT/IB/308

PCT/RO/101

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) New Application	INTERNATIONAL APPLICATION NO. PCT/JP00/05048	ATTORNEY'S DOCKET NUMBER L9289.01124 PCT
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21. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1,000.00 <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY <div style="border: 1px solid black; height: 100px; width: 100%;"></div>																																																																							
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<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:15%;">CLAIMS</th> <th style="width:20%;">NUMBER FILED</th> <th style="width:20%;">NUMBER EXTRA</th> <th style="width:10%;">RATE</th> <th style="width:15%;"></th> <th style="width:10%;"></th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>13 - 20 =</td> <td>0</td> <td>x \$18.00</td> <td></td> <td style="text-align: right;">\$0.00</td> </tr> <tr> <td>Independent claims</td> <td>7 - 3 =</td> <td>4</td> <td>x \$80.00</td> <td></td> <td style="text-align: right;">\$320.00</td> </tr> <tr> <td colspan="5">Multiple Dependent Claims (check if applicable). <input type="checkbox"/></td> <td style="text-align: right;">\$0.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">TOTAL OF ABOVE CALCULATIONS =</td> <td style="text-align: right;">\$1,180.00</td> </tr> <tr> <td colspan="5" style="padding: 5px;"> Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/> </td> <td style="text-align: right; vertical-align: bottom;">\$0.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">SUBTOTAL =</td> <td style="text-align: right;">\$1,180.00</td> </tr> <tr> <td colspan="4" style="padding: 5px;"> Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). </td> <td style="text-align: center; vertical-align: middle;">+</td> <td style="text-align: right; vertical-align: bottom;">\$0.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">TOTAL NATIONAL FEE =</td> <td style="text-align: right;">\$1,180.00</td> </tr> <tr> <td colspan="4" style="padding: 5px;"> Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input checked="" type="checkbox"/> </td> <td></td> <td style="text-align: right; vertical-align: bottom;">\$40.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">TOTAL FEES ENCLOSED =</td> <td style="text-align: right;">\$1,220.00</td> </tr> <tr> <td colspan="5"></td> <td style="text-align: right; vertical-align: bottom;"> Amount to be: refunded \$ charged \$ </td> </tr> </tbody></table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE			Total claims	13 - 20 =	0	x \$18.00		\$0.00	Independent claims	7 - 3 =	4	x \$80.00		\$320.00	Multiple Dependent Claims (check if applicable). <input type="checkbox"/>					\$0.00	TOTAL OF ABOVE CALCULATIONS =					\$1,180.00	Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>					\$0.00	SUBTOTAL =					\$1,180.00	Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				+	\$0.00	TOTAL NATIONAL FEE =					\$1,180.00	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input checked="" type="checkbox"/>					\$40.00	TOTAL FEES ENCLOSED =					\$1,220.00						Amount to be: refunded \$ charged \$
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☒ A check in the amount of **\$1,220.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
 A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO: James E. Ledbetter STEVENS, DAVIS, MILLER & MOSHER, LLP 1615 L Street, NW, Suite 850 Washington, DC 20036 Tel: 202/785-0100 Fax: 202/408-5200	<div style="text-align: center;"> SIGNATURE </div> <div style="text-align: center;"> James E. Ledbetter NAME </div> <div style="text-align: center;"> 28,732 REGISTRATION NUMBER </div> <div style="text-align: center;"> March 26, 2001 DATE </div>
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DESCRIPTION

APPARATUS AND METHOD FOR RADIO COMMUNICATIONS

5 Technical Field

The present invention relates to an apparatus and method for radio communications.

Background Art

10 In a conventional mobile radio communication system, transmit power of a signal is controlled according to signal power loss in a radio propagation path (hereinafter referred to as "propagation path loss") and according to a data transmission rate. That
15 is, as the radio propagation path environment becomes worse and propagation path loss increases, the transmitting side sends signals with increased transmit power to meet the desired communication quality on the receiving side. Furthermore, since a data error rate on
20 the receiving side increases as the transmission rate increases, the transmitting side sends signals with transmit power increased as the transmission rate increases so that the data error rate falls within a certain range.

25 However, in the conventional transmit power control described above, when a propagation path environment between a mobile station and a base station (hereinafter referred to as "between the own stations")

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deteriorates due to shadowing, etc., and the transmitting side increases transmit power, the communication quality between the own stations is satisfied, but the communication between the own stations may constitute interference with a communication between other mobile station and the base station in the same cell and between other mobile station and a base station in another cell (hereinafter collectively referred to as "between other stations"), deteriorating the communication quality between other stations. In this case, between other stations, the transmitting side increases transmit power to maintain the communication quality. However, this constitutes interference between the own stations, and therefore the transmitting side further increases transmit power between the own stations. Continuing such transmit power control between each mobile station and base station will produce a problem that the communication quality for the entire system will not show even the slightest improvement and the channel utilization efficiency in the entire system will also deteriorate.

Moreover, when a mobile station demands a communication at high transmission rate, the transmitting side sends data with increased transmit power. Therefore this communication at the increased transmission rate constitutes interference with a communication between other stations and deteriorates the communication quality between the other stations

producing the same problem described above. In this case, the problem above may be solved by prohibiting the mobile station demanding for a communication at an increased transmission rate from continuing the communication itself, but prohibiting the communication itself is not a desirable means for solving the problem in providing a communication service.

Disclosure of Invention

10 It is an object of the present invention to provide a radio communication apparatus and a radio communication method that carries out a radio communication at a transmission rate that meets a desired communication quality according to propagation path loss taking into account the channel capacity of an entire service area.

15 The inventor et al. of the present invention focused attention on the fact that the above problem occurs because transmit power control is performed between each mobile station and base station independently without taking into account interference with communications between other stations or the channel utilization efficiency of the entire system and the transmission rate is determined according to a demand from each mobile station without taking into account a communication environment of each mobile station.

To attain the above object, the present invention therefore determines a transmit power value in a

communication between the own stations that will not constitute interference with communications between other stations based on transmit power values in the communications between the other communications and
5 performs the communication between the own stations with a transmission rate value based on the determined transmit power value capable of achieving sufficient communication quality.

10 Brief Description of Drawings

FIG.1 is a main block diagram showing an outlined configuration of a base station apparatus according to an embodiment of the present invention;

FIG.2 is a main block diagram showing an outlined
15 configuration of a mobile station apparatus according to the embodiment of the present invention;

FIG.3 is a transmission rate determination table of the base station apparatus of the embodiment of the present invention; and

20 FIG.4 is a sequence diagram to explain the operations of the mobile station apparatus and base station apparatus according to the embodiment of the present invention.

25 Best Mode for Carrying out the Invention

With reference now to the attached drawings, an embodiment of the present invention will be explained in detail below. In the following explanations, a mobile

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communication base station apparatus (hereinafter referred to as "base station apparatus") and a mobile communication terminal apparatus (hereinafter referred to as "mobile station apparatus") will be explained as the radio communication apparatuses.

(Embodiment)

FIG.1 is a main block diagram showing an outlined configuration of a base station apparatus according to an embodiment of the present invention, FIG.2 is a main block diagram showing an outlined configuration of a mobile station apparatus according to the embodiment of the present invention and FIG.3 is a transmission rate determination table of the base station apparatus of the embodiment of the present invention.

In base station apparatus 100 in FIG.1, duplexer 102 performs switching control to carry out transmission and reception through a single antenna 101. Reception RF section 103 amplifies a reception signal and then converts the frequency of the reception signal to an intermediate frequency or baseband frequency. Demodulation/decoding section 104 demodulates/decodes the reception signal converted to the intermediate frequency or baseband frequency to obtain reception data.

When the mobile station apparatus sends a call connection request to base station apparatus 100, transmit power determination section 105 determines a

transmit power value in such a way as not to constitute interference with communications between other stations.

For example, transmit power determination section 5 105 determines a transmit power value that will not constitute interference with communications between other stations based on the transmit power value of the communication currently being carried out between base station apparatus 100 and all mobile station apparatuses. 10 More specifically, transmit power determination section 105 prevents interference with communications between other stations by controlling each transmit power value of a communication with each mobile station apparatus in the same cell to a certain value or below and 15 controlling the sum total of uplink transmit power values in the same cell and the sum total of downlink transmit power values in the same cell to a certain value or below.

Furthermore, it is also possible to determine a transmit power value using the following method for 20 instance. That is, in response to a call connection request from the mobile station apparatus, the base station apparatus sends a predetermined transmit power value and a predetermined transmission rate value to the mobile station apparatus as control information first. 25 In response to this, the mobile station apparatus sends a known reference signal, etc. to the base station apparatus with a transmit power value and transmission rate value based on the control information. After the

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control information is sent until the known reference signal, etc. is received, the base station apparatus measures interference power values and SIR values in communications between other stations and thereby

5 estimates the extent of interference with the communications between the other stations caused by the known reference signal, etc. sent from the mobile station apparatus. Then, when the base station apparatus estimates that the known reference signal, etc. sent from

10 the mobile station apparatus will cause considerable interference with the communications between the other stations to an extent that the desired communication quality will no longer be satisfied, the base station apparatus reduces the transmit power value, and when it

15 is possible to estimate that the amount of interference is small, the base station apparatus increases the transmit power value and resends the transmit power value to the mobile station apparatus as the control information. Thus, the base station apparatus and

20 mobile station apparatus repeat communications a plurality of times while maintaining a certain transmission rate and changing a transmit power value, and in this way a maximum transmit power value that will not interfere with communication between other stations

25 is determined.

The method of determining a transmit power value is not limited to these methods, but can be any method that can at least determine a transmit power value that

will not interfere with communication between other stations.

Transmit power control section 106 performs transmit power control on transmission RF section 107 according to the transmit power value determined by transmit power determination section 105.

Transmission RF section 107 amplifies the modulated data up to the transmit power value controlled by transmit power control section 106 and sends the modulated data via duplexer 102 and antenna 101.

SIR measurement section 108 measures a signal to interference ratio (hereinafter referred to as "SIR") of the known reference signal in the reception signal.

Transmission rate determination section 109 determines a transmission rate value from the transmit power value determined by transmit power determination section 105, the SIR value of the uplink channel measured by SIR measurement section 108 and the SIR value of the downlink channel notified to base station apparatus 100 by the mobile station apparatus.

More specifically, transmission rate determination section 109 has a transmission rate determination table as shown in FIG.3, which is a table that shows the correspondence between transmit power values, SIR values and transmission rate values and determines a transmission rate value that corresponds to a transmit power value and SIR value with reference to this table. As shown in FIG.3, the transmission rate

determination table is preset to meet the desired communication quality in such a way that the transmission rate value decreases as the transmit power value decreases, and the transmission rate value decreases as the SIR value decreases. That is, the base station apparatus and mobile station apparatus can communicate at a higher transmission rate as the transmit power value and SIR value increase and can communicate only at a lower transmission rate as the transmit power value and SIR value decrease. Now, suppose the transmit power value is 15 [dBm] and SIR value is 15 [dB/μ], then the transmission rate value is determined as 384 [kbps] from the transmission rate determination table. Thus, use of the transmission rate determination table allows a transmission rate value to be determined simply and quickly.

Here, the numbers shown in FIG.3 are used for the sake of convenience to illustrate a relationship between values large and small and are not intended to indicate actual determined values or measured values. Moreover, the specific correspondence between the transmit power values, SIR values and transmission rate values is predetermined optimally so as to meet the desired quality according to results of a simulation or field test, etc. Here, an optimal transmission rate value is determined using a table, but the method of determining an optimal transmission rate value is not limited to this method, and can be any method that can at least determine an

optimal transmission rate value.

Here, a transmission rate value is determined based on not only a transmit power value but also SIR value because it is necessary to take into account propagation path loss, etc. in addition to a transmit power value in determining a transmission rate value. That is, even if data is sent with a same transmit power value, the reception power value on the receiving side decreases as propagation path loss increases, and in effect this would be not different from the case where the transmit power value is small. Therefore, an SIR value is also used as an index of propagation path loss to determine the transmission rate value, and the transmission rate value is decreased as the SIR value decreases, whereby the desired communication quality is satisfied.

Furthermore, the transmission rate value is determined using both an SIR value of the uplink channel and an SIR value of the downlink channel because this embodiment takes into account the case where the base station apparatus of this embodiment is applied to a radio communication system using an FDD (Frequency Division Duplex) system. That is, because in the case of the FDD system, the uplink channel and downlink channel use different frequency bands and have different propagation path characteristics, and therefore it is necessary to take into account propagation path loss, etc. on both channels. Therefore, when the base station apparatus of this embodiment is applied to a TDD (Time

Division Duplex) system in which a same frequency band is used for the uplink channel and downlink channel, the uplink channel and downlink channel will have a same propagation path characteristic, and therefore using the
5 SIR value of either the uplink channel or downlink channel suffices.

Transmission rate control section 110 controls the transmission rate of transmission frame composition section 111 according to the transmission rate value
10 determined by transmission rate determination section 109.

Transmission frame composition section 111 superimposes the transmit power value determined by transmit power determination section 105 and the
15 transmission rate value determined by transmission rate determination section 109 over control data sent via a control channel and thereby composes a transmission frame. Furthermore, transmission frame composition section 111 composes user data sent via a communication
20 channel into a transmission frame sent at a transmission rate controlled by transmission rate control section 110. Coding/modulation section 112 encodes/modulates the frame-composed transmission data.

On the other hand, in mobile station apparatus 200
25 in FIG.2, duplexer 202 performs switching control to carry out transmission and reception through a single antenna 201. Reception RF section 203 amplifies a reception signal and then converts the frequency of the

reception signal to an intermediate frequency or
baseband frequency. Demodulation/decoding section 204
demodulates/decodes the reception signal converted to
the intermediate frequency or baseband frequency to
5 obtain reception data.

Transmit power control section 205 detects a
transmit power value superimposed over the control data
sent from base station apparatus 100 and performs
transmit power control on transmission RF section 206
10 according to the transmit power value.

Transmission RF section 206 amplifies the
modulated data up to the transmit power value controlled
by transmit power control section 205 and sends the
modulated data via duplexer 202 and antenna 201.

15 SIR measurement section 207 measures an SIR of the
known reference signal in the reception signal.
Transmission rate control section 110 detects a
transmission rate value superimposed over the control
data sent from base station apparatus 100 and controls
20 the transmission rate of transmission frame composition
section 209 according to the transmission rate value.

Transmission frame composition section 209
superimposes the SIR value measured by SIR measurement
section 207 over the control data and thereby composes
25 a transmission frame. Furthermore, transmission frame
composition section 209 composes user data into a
transmission frame at a transmission rate controlled by
transmission rate control section 208.

Coding/modulation section 210 encodes/modulates the frame-composed transmission data.

Then, the operations of the mobile station apparatus and base station apparatus in the above 5 configurations will be explained using FIG.4. FIG.4 is a sequence diagram to explain the operations of the mobile station apparatus and base station apparatus according to the embodiment of the present invention.

First, at timing 401, mobile station apparatus 200 10 starts a call and sends a call connection request signal via a control channel to base station apparatus 100. At timing 410, base station apparatus 100 receives the call connection request signal. Then, at base station apparatus 100, transmit power determination section 105 15 detects the call connection request signal demodulated/decoded by demodulation/decoding section 104.

Then, at timing 411, at base station apparatus 100, transmit power determination section 105 determines a 20 transmit power value. The determined transmit power value is output to transmit power control section 106 and transmission frame composition section 111. Then, transmission frame composition section 111 superimposes the transmit power value and known reference data over 25 the control data and thereby composes a transmission frame. This transmission frame is encoded/modulated by coding/modulation section 112, controlled to certain transmit power and a certain transmission rate by

transmission RF section 107 and sent through duplexer 102 and antenna 101 to mobile station apparatus 200 via a control channel.

Then, at timing 402, mobile station apparatus 200
5 receives the control signal. SIR measurement section 207 at mobile station apparatus 200 detects a known reference signal from the control signal converted to an intermediate frequency or baseband frequency by reception RF section 203. Furthermore, transmit power
10 control section 205 detects a transmit power value from the control signal demodulated/decoded by demodulation/decoding section 204.

Then, at timing 403, at mobile station apparatus 200, SIR measurement section 207 measures the SIR of the
15 known reference signal to estimate the propagation path loss of the downlink channel and outputs the measured SIR value of the downlink channel to transmission frame composition section 209. Transmission frame
composition section 209 then superimposes the SIR value
20 of the downlink channel and known reference data over the control data and thereby composes a transmission frame. This transmission frame is encoded/modulated by coding/modulation section 210, controlled to certain transmit power and a certain transmission rate by
25 transmission RF section 206 and sent through duplexer 202 and antenna 201 to base station apparatus 100 via a control channel.

Then, at timing 412, base station apparatus 100

receives the control signal. At base station apparatus 100, SIR measurement section 108 detects the known reference signal from the control signal converted to an intermediate frequency or baseband frequency by reception RF section 103 and measures the SIR of the known reference signal to estimate the propagation path loss of the uplink channel. The measured SIR value of the uplink channel is output to transmission rate determination section 109. Transmission rate determination section 109 detects the SIR value of the downlink channel from the control signal demodulated/decoded by demodulation/decoding section 104. Thus, base station apparatus 100 estimates the propagation path loss on the uplink and downlink channels accurately.

Then, at timing 413, transmission rate determination section 109 at base station apparatus 100 determines a transmission rate value from the transmit power value determined at timing 411 and the SIR value of the downlink channel and the SIR value of the uplink channel measured and detected at timing 412 according to the table held by transmission rate determination section 109. The determined transmission rate value is output to transmission rate control section 110 and transmission frame composition section 111. Then, transmission frame composition section 111 superimposes the transmission rate value over the control data and thereby composes a transmission frame. This

transmission frame is sent to mobile station apparatus 100 through the same operation as the operation at timing 411 via the control channel.

This embodiment assumes the case where the mobile station apparatus and base station apparatus are applied to an FDD-based communication system, and therefore the transmission rate value is determined using both the SIR value of the downlink channel and the SIR value of the uplink channel. However, in a case where the mobile station apparatus and base station apparatus of this embodiment are applied to a TDD-based communication system, it is also possible to adopt a configuration using either one of the SIR value of the downlink channel or the SIR value of the uplink channel.

Then, at timing 404, mobile station apparatus 200 receives the control signal. Transmission rate control section 208 at mobile station apparatus 200 detects a transmission rate value from the control signal demodulated/decoded by demodulation/decoding section 204. Thus, mobile station apparatus 200 acquires the transmit power value and transmission rate value when user data is transmitted, and therefore mobile station apparatus 200 sends user data according to the acquired transmit power value and transmission rate value from timing 405 onward.

That is, at mobile station apparatus 200, the user data is composed into a transmission frame by transmission frame composition section 209 at the

transmission rate controlled by transmission rate control section 208 and output to coding/modulation section 210. The transmission frame coded/modulated by coding/modulation section 210 is amplified by

5 transmission RF section 206 up to a transmit power value controlled by transmit power control section 205 and sent through duplexer 202 and antenna 201.

On the other hand, from timing 414 onward, base station apparatus 100 sends user data through the same
10 operation as the operation of mobile station apparatus 200 from timing 405 onward. That is, at base station apparatus 100, the user data is composed into a transmission frame by transmission frame composition section 111 at the transmission rate controlled by
15 transmission rate control section 110 and output to coding/modulation section 112. The transmission frame coded/modulated by coding/modulation section 112 is amplified by transmission RF section 107 to a transmit power value controlled by transmit power control section
20 106 and sent through duplexer 102 and antenna 101.

As shown above, a communication between base station apparatus 100 and mobile station apparatus 200 is carried out with the transmit power value and transmission rate value determined at base station
25 apparatus 100.

This embodiment describes the case where mobile station apparatus 200 sends a call, but in the case where mobile station apparatus 200 receives an incoming call,

it is also possible to determine transmit power, measure SIRs and determine a transmission rate through the same operation as that described above.

Furthermore, the transmission rate determined in this embodiment is the transmission rate at an upper limit, and therefore it is also possible to carry out communications using a transmission rate equal to or lower than the determined transmission rate.

Furthermore, this embodiment adopts a configuration measuring the SIR of a known reference signal to estimate propagation path loss, but it is also possible to adopt a configuration in which the transmitting side sends the transmit power value to the receiving side and the receiving side compares the transmit power value transmitted with the actual reception power value to estimate propagation path loss. Such a configuration makes it possible to accurately estimate propagation path loss on the channel from the transmitting side to the receiving side.

20 Furthermore, assuming a case where the mobile station apparatus is in a stationary state and there is no need to adaptively change the transmission rate, this embodiment adopts a configuration in which the transmission rate is determined before communication of
25 user data is started to alleviate the load of processing for determining the transmission rate value and communication of user data is performed using a fixed transmission rate. However, it is also possible to adopt

a configuration in which the transmission rate is variable adaptively during communication of user data. That is, it is also possible to adopt a configuration in which base station apparatus 100 and mobile station apparatus 200 measure SIRs at any time even after communication of user data is started, transmission rate determination section 109 of base station apparatus 100 determines the transmission rate with reference to the table every time according to the measured SIR.

Moreover, in this case, it is also possible to adopt a configuration in which the transmission rate is determined based on an average of SIR in an arbitrary period or a variation of SIR in an arbitrary period. Determining the transmission rate based on an average of SIR allows the transmission rate to be determined taking into account the distance characteristic and shadowing characteristic, and determining the transmission rate based on a variation of SIR allows the transmission rate to be determined taking into account the moving direction and moving speed of the mobile station apparatus.

Furthermore, this embodiment adopts a configuration in which the base station apparatus estimates propagation path loss, but it is also possible to adopt a configuration in which the mobile station apparatus estimates propagation path loss.

As shown above, the base station apparatus, mobile station apparatus or radio communication method

As described above, the present invention allows a radio communication with a transmission rate that meets the desired communication quality according to propagation path loss taking into account the channel capacity of the entire service area.

As described above, the present invention allows a radio communication with a transmission rate that meets the desired communication quality according to propagation path loss taking into account the channel capacity of the entire service area.

This application is based on the Japanese Patent Application No.HEI 11-216314 filed on July 30, 1999, entire content of which is expressly incorporated by reference herein.

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Industrial Applicability

The present invention is applicable to a base station apparatus used in a radio communication system or a communication terminal apparatus such as a mobile station apparatus that carries out a radio communication with this base station apparatus.

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What is claimed is:

1. A radio communication apparatus comprising:

a transmit power determiner for determining a transmit power value that will not interfere with communications between other stations based on a transmit power value obtained from the communications between the other stations;

an estimator for estimating propagation path loss of a communication channel based on propagation path loss information; and

a transmission rate determiner for determining a transmission rate value that will meet desired communication quality according to the determined transmit power value and the estimated propagation path loss.

2. A radio communication apparatus comprising:

a receiver for receiving a transmit power value and a transmission rate value determined by the other end of communication; and

a transmitter for transmitting user data with the transmit power value and the transmission rate value.

3. The radio communication apparatus according to claim 1, wherein the estimator estimates the propagation path loss, as the propagation path loss information, using a value indicating the reception quality of a known reference signal sent back from the other end of

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communication in response to the known reference signal transmitted from the radio communication apparatus.

4. The radio communication apparatus according to claim 1, wherein the estimator estimates the propagation path loss, as the propagation path loss information, using the reception power value and the transmit power value sent from the other end of communication.

10 5. The radio communication apparatus according to claim 1, wherein the estimator estimates the propagation path loss based on the propagation path loss information acquired a plurality of times during a predetermined time.

15 6. The radio communication apparatus according to claim 1, wherein the transmission rate determiner has a table of correspondence between determined transmit power values, estimated propagation path loss and transmission rate values and determines the transmission rate value with reference to the table of correspondence.

20

7. The radio communication apparatus according to claim 1, further comprising a transmitter for transmitting the determined transmit power value and the determined transmission rate value as a control signal and transmitting user data with the determined transmit power value and the determined transmission rate value.

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8. A base station apparatus equipped with a radio communication apparatus, the radio communication apparatus comprising:

5 a transmit power determiner for determining a transmit power value that will not interfere with communications between other stations based on a transmit power value obtained from the communications between the other stations;

10 an estimator for estimating propagation path loss of a communication channel based on propagation path loss information; and

 a transmission rate determiner for determining a transmission rate value that will meet desired
15 communication quality according to the determined transmit power value and the estimated propagation path loss.

9. A base station apparatus equipped with a radio
20 communication apparatus, the radio communication apparatus comprising:

 a receiver for receiving a transmit power value and a transmission rate value determined by the other end of communication; and

25 a transmitter for transmitting user data with the transmit power value and the transmission rate value.

10. A communication terminal apparatus equipped with a

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radio communication apparatus, the communication terminal apparatus comprising:

5 a transmit power determiner for determining a transmit power value that will not interfere with communications between other stations based on a transmit power value obtained from the communications between the other stations;

10 an estimator for estimating propagation path loss of a communication channel based on propagation path loss information; and

15 a transmission rate determiner for determining a transmission rate value that will meet desired communication quality according to the determined transmit power value and the estimated propagation path loss.

11. A communication terminal apparatus equipped with a radio communication apparatus, the communication terminal apparatus comprising:

20 a receiver for receiving a transmit power value and a transmission rate value determined by the other end of communication; and

25 a transmitter for transmitting user data with the transmit power value and the transmission rate value.

12. A radio communication method, wherein one radio communication apparatus determines a transmit power value that will not interfere with communications

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between other stations based on a transmit power value
obtained from the communications between the other
stations, estimates propagation path loss of a
communication channel, determines a transmission rate
5 value that will meet desired communication quality
according to the determined transmit power value and the
estimated propagation path loss, sends the determined
transmit power value and the determined transmission
rate value as a control signal and sends user data with
10 the determined transmit power value and the determined
transmission rate value, and

the other radio communication apparatus sends user
data with the transmit power value and the transmission
rate value sent from the one radio communication
15 apparatus.

13. The radio communication method according to claim
12, wherein the transmission rate value is determined
before the user data is sent and the transmission rate
20 value is not changed until the communication is
completed.

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ABSTRACT

Transmit power determination section 105
determines a transmit power value in a communication
between the own stations that will not interfere with
5 communications between other stations based on the
transmit power value in the communications between the
other stations, SIR measurement section 108 measures an
SIR of a known reference signal in the reception signal
and transmission rate determination section 109
10 determines a transmission rate value that will meet the
desired communication quality according to the
determined transmit power value and measured SIR value.

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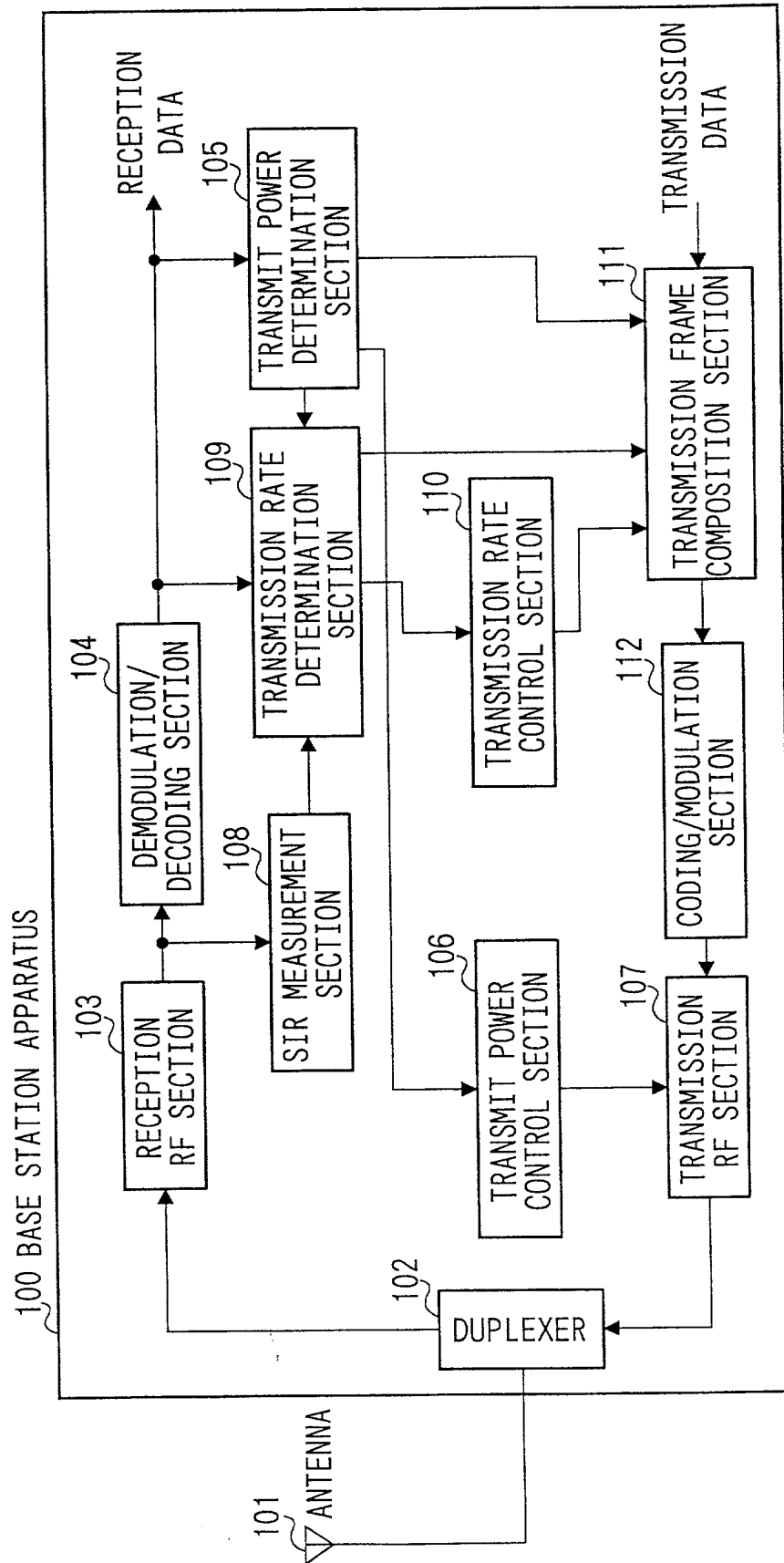


FIG. 1

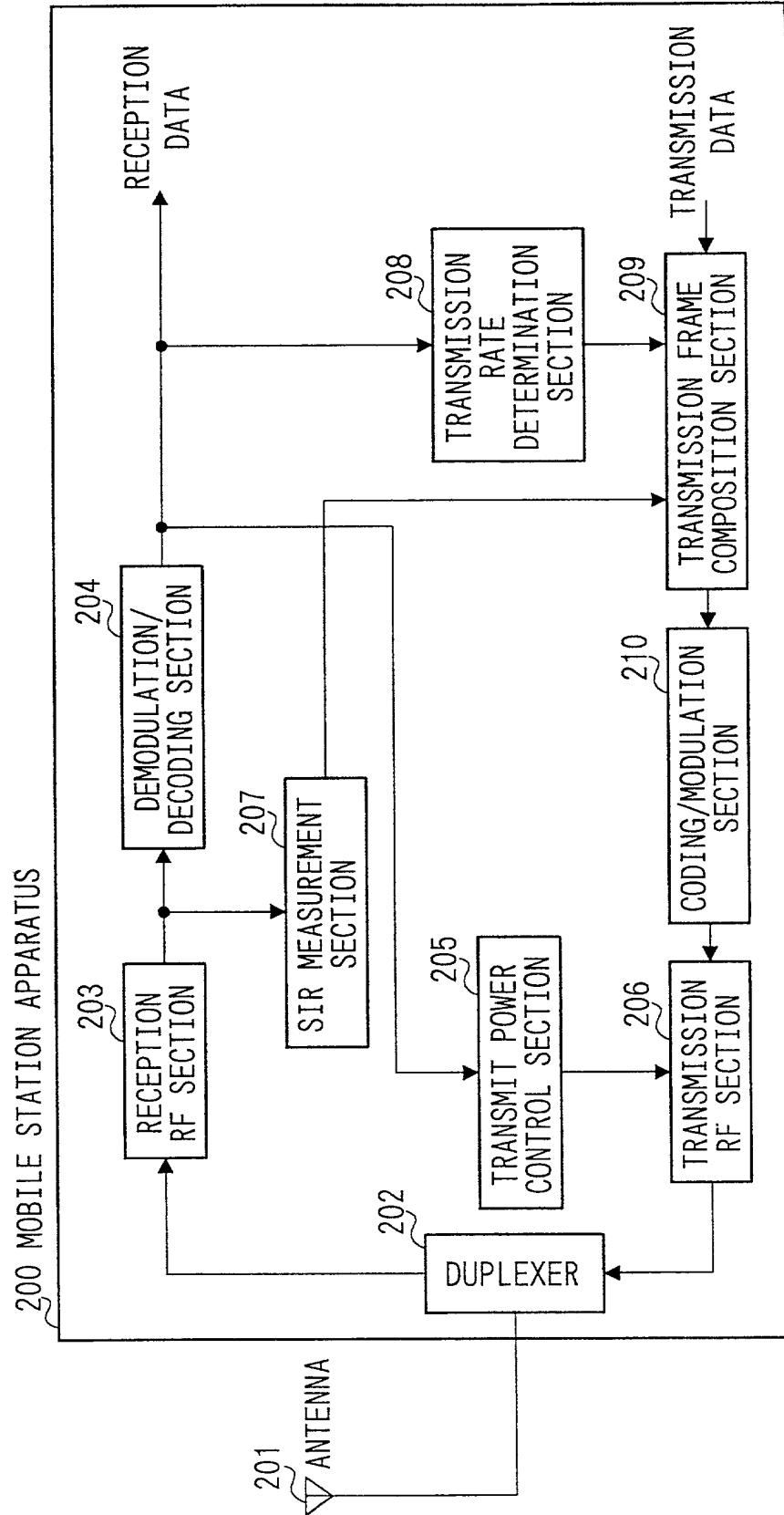


FIG. 2

TRANSMISSION RATE DETERMINATION TABLE

TRANSMISSION RATE VALUE [bps]				
SIR VALUE [dBμ]	TRANSMIT POWER VALUE [dBm]	BELOW +10	BETWEEN +10 AND +21	+21 OR ABOVE
BELOW +10		8k	32k	384k
BETWEEN +10 AND +21		32k	384k	1M
+21 OR ABOVE		384k	1M	2M

FIG. 3

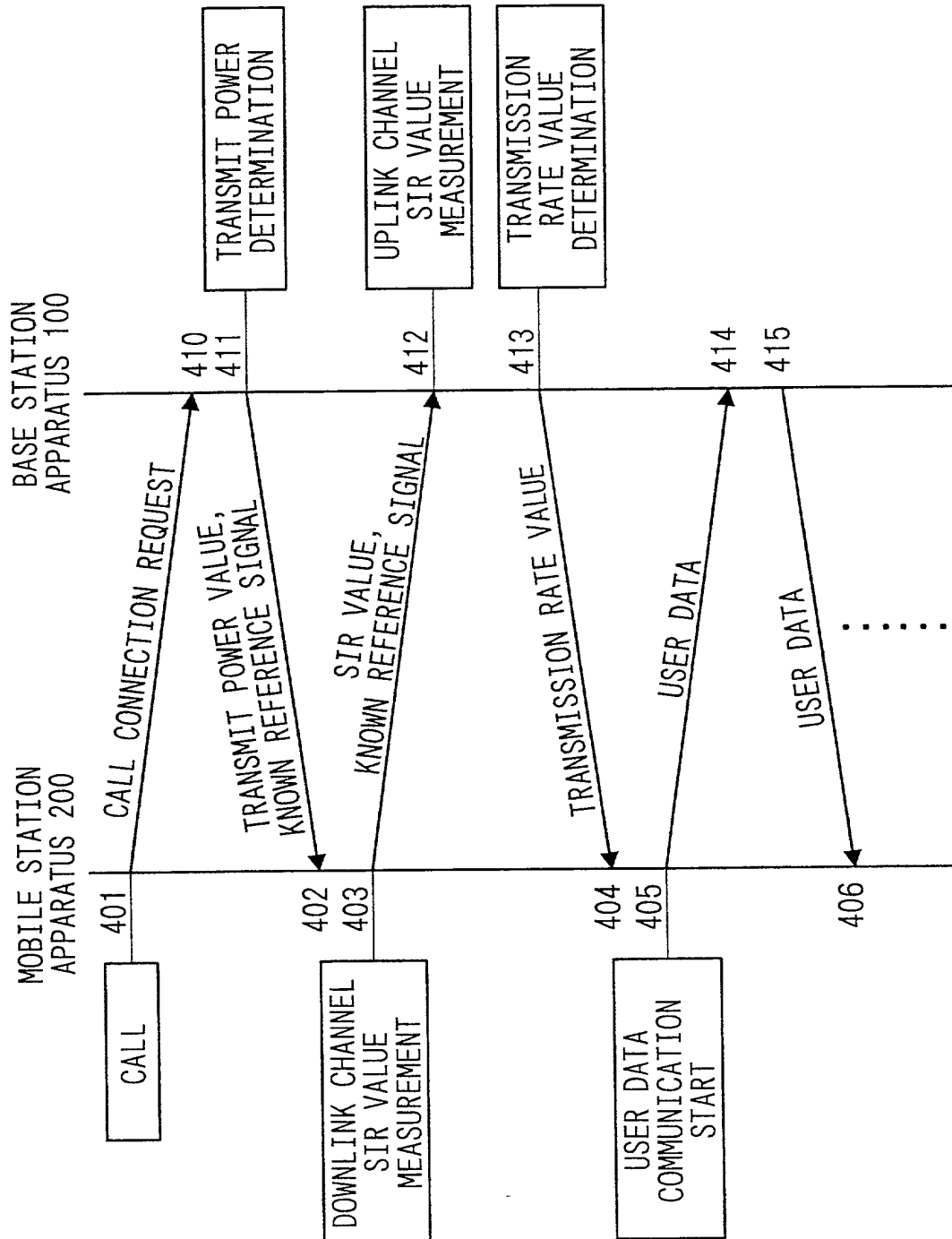


FIG. 4

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: APPARATUS AND METHOD FOR RADIO COMMUNICATIONS

the specification of which 2 (file no _____)

(check at least one) 3 ☒ is attached hereto

4 ☐ was filed on _____ as (5) U.S. Application Serial No. _____

6 ☐ and was amended _____
(if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.	7 <input checked="" type="checkbox"/>	was filed as PCT international application		
	8	Number	<u>PCT/JP00/05048</u>	
	9	on	<u>July 28, 2000</u>	
	10	and was amended under PCT Article(s) 19 and/or 34 on _____ (if applicable).		
	11	priority date claimed in PCT International Application		
		<u>JAPAN</u>	<u>JP11-216314</u>	<u>30/July/1999</u>
		(Country)	(Number)	(Day/Month/Year Filed)
		_____	_____	_____
		(Country)	(Number)	(Day/Month/Year Filed)
		_____	_____	_____
		(Country)	(Number)	(Day/Month/Year Filed)

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119			Priority Claimed	
12a	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
	(Country)	(Number)	Yes	No
	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
	(Country)	(Number)	Yes	No
Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:				

12b	Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed
	_____	_____	_____	_____

Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application	I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.		
	13	_____	_____
	(U.S. Application Number)	(U.S. Filing Date)	Status (patented, pending, abandoned)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

3 James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.
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See page 2 for signature lines

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

14a	Typewritten Full Name of Sole or First Inventor	<u>1-6</u> Takahiro	SHOJI
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15a	Inventor's Signature	<u>Takahiro</u>	<u>Shoji</u>
16a	Date of Signature	<u>February</u> <u>23</u> <u>2001</u>	Month Day Year
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16d	Date of Signature		
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17d	Residence		
		City	State or Province Country
18d	Citizenship		
19d	Post Office Address (Insert complete mailing address, including country)		

*Note to Inventor: Please sign name on line 15 exactly as it appears in line 14 and insert the actual date of signing on line 16. If there are more than four inventors, please add a copy of this page for identification and signatures for the additional inventors.